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Nano-spinel synthesis using Fe(III)-reducing bacteria

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Geobacter sulfurreducens is a bacterium capable of reducing amorphous iron(III) oxide through electron transfer coupled to organic matter oxidation, converting the iron to nano-sized magnetic particles of magnetite (Fe_3O_4), with a size of approx. 20 nm [1] (Fig. 1).

Nano-spinels of the general chemical formula $M_xFe_{3-x}O_4$, where *M* is a transition metal cation other than Fe, such as Co, Ni or Mn, have been produced using the capability of *G. sulfurreducens* to form nanomagnets[2]. These materials have different electrical, magnetic, and structural properties, from coarse grained materials making them ideal for use in technical devices. Characterization of these nanoparticles has been carried out using the synchrotron radiation spectroscopies XMCD (x-ray magnetic circular dichroism) and EXAFS in addition to SQUID magnetometry and TEM.

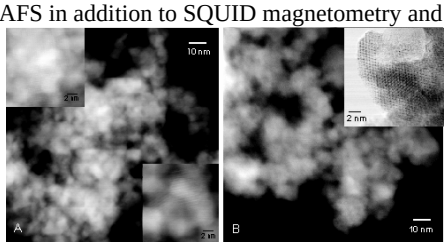

Figure 1. superSTEM images of (A) Co-biospinel, (B) Ni-biospinel.

The extraordinary capability of bacteria to produce nano-magnets has not yet been exploited by industry and such processes have enormous commercial potential. In addition, the ability of the bacteria to precipitate magnetite from Fe(III) oxides could be used as a bioremediation strategy to clean up environments contaminated by Fe(III)-oxides, such as acid mine drainage (AMD) sites, inexpensively and effectively.

[1] Lovley, D, Stoltz, JF, Nord Jr, G and Phillips, E. (1987), *Nature*, **330** 252-254.
[2] Coker, V, Pearce, C, Pattrick, R, van der Laan, G, Telling, N, Charnock, J, Arenholz, E. & Lloyd, J (2007) *Am Mineral*, submitted.